Materials Engineering Branch

TIP*

No. 125 Problems with Pure Tin Coatings[1]

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Tin plating is occasionally used on flight hardware for corrosion protection and solderability. Pure tin has exhibited two types of undesirable behavior in the past: whisker growth and low temperature transformation ("tin pest" or "tin disease"). The risk of whisker growth is significant enough to be a major obstacle to the use of tin in miniaturized electronic components.

Whisker growth and transformation are promoted by high purity. High residual stress levels also promote whisker growth. Incubation periods of extremely large variance, days to years, have been observed. If tin must be used in a susceptible application, there are several treatments that minimize or eliminate both types of behavior:

- Co-deposit lead during plating. The tin-plating specification, ASTM B545 requires the use of high purity tin and the requester must specify any co-deposition. An alloy of tin-7% lead (±5%) is extensively used. Solder coating can also be substituted for tin in some cases.

- Flow brightening at 260°C or stress relieving at 180-200°C for 1 hour reduces residual stresses and the risk of undesirable behavior. Thermal effects on adjacent materials need to be considered. Using an inert atmosphere during stress relieving may be necessary to maintain solderability.

The following additional information may be helpful in evaluating applications:

WHISKER GROWTH

- Of the electrical platings, tin is most susceptible to whisker growth. Whisker lengths are typically up to 1 to 2 millimeters, and lengths of 4 to 5 millimeters have been reported.

- Whisker growth can occur from -40°C to several hundred degrees centigrade in air or vacuum. Growth tendency increases with temperature.

- Barrier coatings such as thick resins or inserts are effective at preventing short circuits.

[1] This TIP is a revision of TIP 021.

- Whiskers can be difficult to detect visually due to their small diameter, typically 2.5 to 12.5 microns (0.1 to 0.5 mils).

- Whiskers can burn out if they make contact in a circuit where sufficient current exists.

TIN TRANSFORMATION

- The transformation from the white tetragonal tin structure to the grey diamond cubic structure is accompanied by an expansion of the crystal lattice and results in a cracked powdery surface.

- The phase change becomes favorable below 10°C and occurs most readily in the temperature range of -40°to -60°C. Low atomic mobility below this range renders the transformation improbable and slow.

- Contact with germanium or silicon has been observed to initiate the transformation.

- Small amounts of lead, antimony and bismuth prevent the transformation.